INSTRUCTION MANUAL

FOR THE

SIGNAL GENERATOR TYPE 225-A

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U.S.A.

1M/CP/8-60

Printed in U.S.A.

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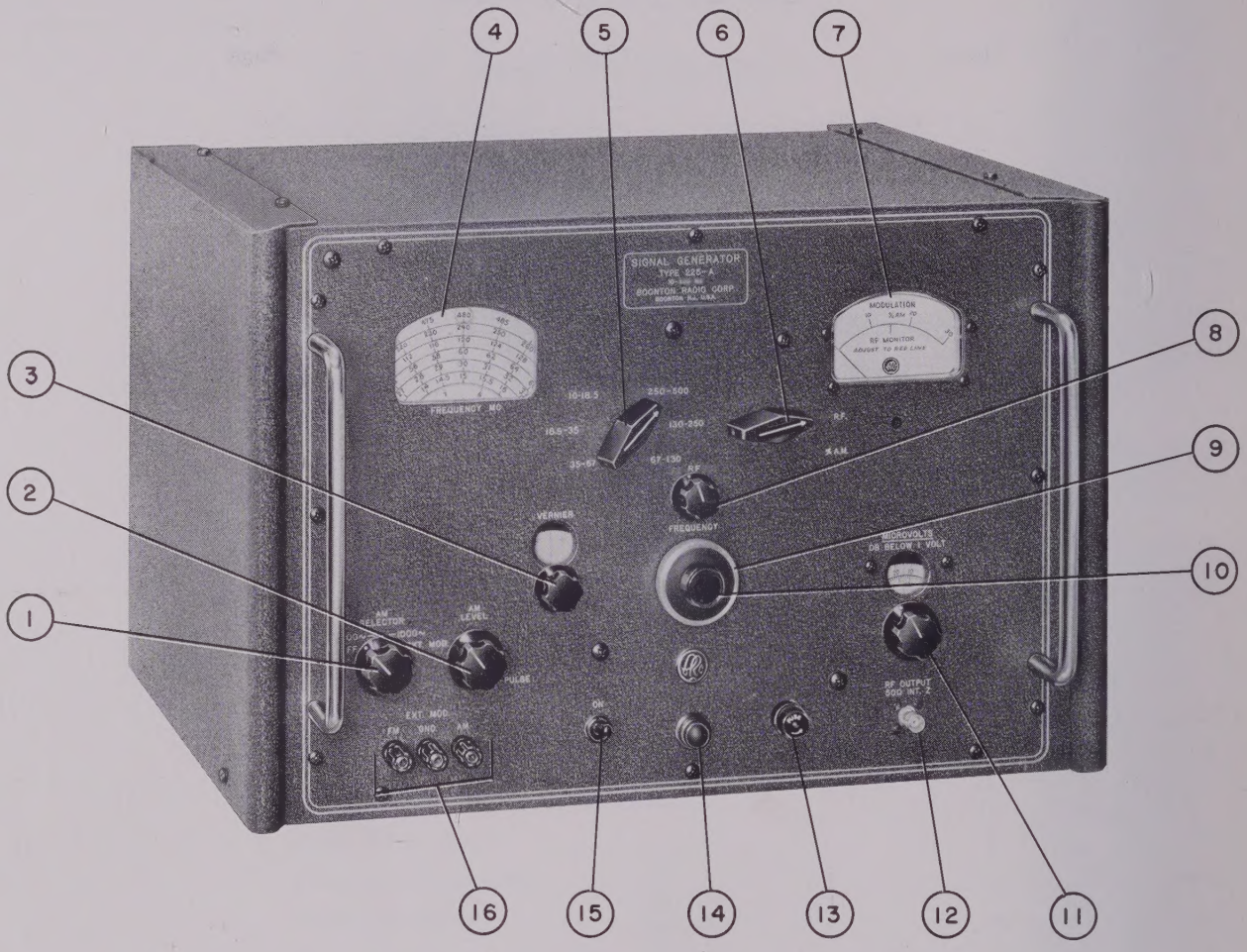


Figure 1. Front Panel Controls

1. *AM SELECTOR*
2. *AM LEVEL Control*
3. *VERNIER Control*
4. *FREQUENCY MC Dial*
5. *Frequency Range Selector*
6. *RF — % AM Switch*
7. *Panel Meter*
8. *RF Control*
9. *FREQUENCY Control*
10. *Trimmer Control*
11. *Attenuator Control*
12. *RF OUTPUT Connector*
13. *Fuse*
14. *Pilot Lamp*
15. *Power Switch*
16. *EXT. MOD. Binding Posts*

SECTION I
INTRODUCTION

DESCRIPTION

The Type 225-A Signal Generator is designed for general purpose use in connection with the development and testing of receivers and associated circuits in the 10 to 500-megacycle frequency range. The instrument incorporates a Master Oscillator-Power Amplifier circuit structurally designed so that the oscillator and power amplifier are housed in separate aluminum castings, affording maximum isolation between the two circuits and resulting in extremely low leakage. Output frequency is adjusted through a precision backlash-free gear train. Output level is continuously adjustable by means of a waveguide-below-cutoff precision piston-type attenuator and is monitored on a "set-to-line" panel meter. Amplitude modulation is available from an internal audio oscillator providing either 400 or 1000-cycle output, or may be obtained from an external source. Provision is also made for frequency and pulse modulation from an external source.

Physically the signal generator consists of three major assemblies: the audio and power supply chassis, the rf assembly, and the front panel assembly. The audio and power supply chassis, which includes the components and wiring for the audio oscillator, audio amplifier, and regulated power supply, is mounted on the instrument baseplate and secured to the side panels at the rear of the instrument. Audio oscillator and amplifier controls are extended by universal-coupled shafts to the front panel.

The rf assembly consists of two rugged aluminum castings which separately house the rf oscillator circuit and the rf amplifier circuit. These castings are mounted on a subplate directly behind the front panel. Viewed from the rear of the instrument, the rf oscillator is contained in the right-hand casting and the rf amplifier in the left-hand casting (Figure 10). Frequency range selecting turrets in each casting are fastened to the ends of a common stainless steel shaft which is in turn driven through bevel gears by the Frequency Range Selector on the front panel. A detent assembly assures positive positioning of the shaft and turrets.

The front panel assembly is secured to the instrument baseplate and side panels. All of the controls necessary for the operation of the signal generator are grouped on this panel in convenient functional order. Handles on either side of the panel serve as a means for carrying the instrument as well as protection for the protruding controls and connectors. End-bells fastened to each side of the instrument are easily removed for mounting in a standard 19-inch rack.

ACCESSORIES FURNISHED

Furnished with each Type 225-A Signal Generator are a Type 501-B Output Cable and a Type 502-B Patching Cable. The 501-B cable, which connects to the rf output connector on the signal generator, is a shielded coaxial cable with a characteristic impedance of 50 ohms. A plug-type BNC connector is attached to one end of the cable and the other end is terminated with a 50-ohm resistor (fitted inside a moulded holder) connected across two binding post connectors. The open-circuit impedance across these binding posts, with the BNC plug connected to the rf output of the 225-A, is 25 ohms. Overall length of the 501-B cable is 3 feet, 3 inches.

The Type 502-B Patching Cable is a shielded coaxial cable with a characteristic impedance of 50 ohms and BNC plug-type connectors provided on each end.

SPECIFICATIONS

Radio Frequency Characteristics

RF RANGE:

Total Range: 10 to 500 Mc.
No. Bands: 6

Band Ranges:		
10 — 18.5 Mc.		67 — 130 Mc.
18.5 — 35 Mc.		130 — 250 Mc.
35 — 67 Mc.		250 — 500 Mc.

RF ACCURACY: ±0.5% (after two hour warmup).

RF SETTABILITY: ±0.05%.

RF CALIBRATION:

Main Dial: Increments of approximately 1%.
Vernier: 1000 divisions through each range.

RF STABILITY:

Short Term: ±0.001%* (5 minutes)
Long Term: ±0.01%* (1 hour)
Line Voltage: ±0.001%* (5 volts)
*After two hour warmup.

RF OUTPUT:

Range: 0.1 μv to 0.1 volts*.
*Across external 50 ohm load.
Accuracy: ±10% 0.1 to 50 K μv, 10 to 250 Mc.
±15% 0.1 to 50 K μv, 250 to 500 Mc.
±20% 0.05 to 0.1 v, 10 to 500 Mc.
Impedance: 50 ohms*.
*25 ohms at terminals of Type 501-B Output Cable.
VSWR: 1.2 maximum.

RF LEAKAGE: Sufficiently low to permit measurements at 0.1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0 to 30%
External: 0 to 30%

AM ACCURACY: ±10% at 30% AM, 10 to 250 Mc.
±15% at 30% AM, 250 to 500 Mc.

AM CALIBRATION: 10, 20, 30%

AM DISTORTION: 5% 10 to 250 Mc.
7% 250 to 500 Mc.

AM FIDELITY: ±1 db 40 cps. to 20 Kc.

INCIDENTAL FM: 0.001% or 1000 cps., whichever is greater, at 30% AM.

EXTERNAL AM REQUIREMENTS: Approximately 10 volts RMS into 4000 ohms for 30% AM.

Frequency Modulation Characteristics

FM RANGE:
External: 0 to between 5 Kc. and 60 Kc., depending upon frequency in the range 130 to 500 Mc.

FM CALIBRATION: Deviation sensitivity vs. frequency nomograph.

INCIDENTAL AM: 10%.

EXTERNAL FM REQUIREMENTS: Approximately 10 volts RMS into 1000 ohms.

Pulse Modulation Characteristics

PM SOURCE: External.

PM RISE TIME: 5 μsec 10 to 40 Mc.
3 μsec 40 to 80 Mc.
2 μsec 80 to 500 Mc.

PM OVERSHOOT: 10% 10 to 100 Mc.
25% 100 to 500 Mc.

EXTERNAL PM REQUIREMENTS: 10 volts peak negative pulse, 20 ma. peak short-circuit capability.

Modulating Oscillator Characteristics

OSC FREQUENCY: 400 and 1000 cps.

OSC ACCURACY: ±10%

Accessories

FURNISHED: Type 501-B Output Cable.
Type 502-B Patching Cable.

AVAILABLE: Type 504-A Adapter
Type 506-B Patching Cable
Type 508-B Adapter
Type 514-B Output Cable
Type 517-B Output Cable

Tube Complement

1 — OC3	2 — 6AU8A
2 — 2AF4A	1 — 12-3H Ballast
1 — 5Y3GT	1 — 543A (Selected 3S6/5)
1 — 6AN4	

Physical Characteristics

MOUNTING: Cabinet for bench use; by removal of end bells, suitable for 19" rack mounting.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 13" Width: 19⅛" Depth: 15"

WEIGHT:

Net:	57 lbs.	Gross Export:	112 lbs.
Gross Domestic:	69 lbs.	Legal Export	66 lbs.

Power Requirements

225-A: 105 — 125 volts, 60 cps., 80 watts.
225-AP: 105 — 125 volts, 50 cps., 80 watts.

SECTION II
OPERATING INSTRUCTIONS

INSTALLATION

The Type 225-A Signal Generator may be installed for bench or rack operation. For bench operation, remove the instrument from its packing carton and place it on a suitable bench. Connect the power cord at the rear of the instrument to a suitable 105 to 125-volt, 60-cps supply. If the instrument is to be installed in a rack, remove the cabinet end-bells and the four rubber feet. Set the power switch to the ON position and allow two hours for warm up. After warm up, perform the following operational checks.

OUTPUT LEVEL CHECK

Set the AM SELECTOR to the OFF position, the RF control to its full clockwise position, and adjust the rf amplifier trimmer control for maximum output. With the Meter Function Switch in the normal (RF) position, observe that it is possible to obtain a "red line" indication on the panel meter for any frequency setting in the 10 to 500-megacycle range. If the output drops below "red line" for a particular frequency setting, readjust the amplifier trimmer control for maximum output.

MODULATING OSCILLATOR CHECK

With the AM SELECTOR in the OFF position and the Meter Function Switch in the normal (RF) position, set the rf amplifier trimmer for maximum output and adjust the RF control so that the pointer on the panel meter indicates "red line". Set the AM SELECTOR to the 400~ position and hold the Meter Function Switch in the % AM position. Rotate the AM LEVEL control in a clockwise direction, while observing the upscale movement of the panel meter pointer, and note that a full scale (30%) indication is attainable within the range of the AM LEVEL control adjustment. Repeat the check with the AM SELECTOR in the 1000~ position.

FRONT PANEL CONTROLS AND INDICATORS

All of the controls and indicators necessary for operation of the signal generator are arranged in functional order on the front panel as shown in Figure 1. The function of each control and indicator is given below.

Power Switch

The Power Switch applies line voltage to the power supply when set to the ON position.

Fuse

A 1-ampere fuse, connected in series with the primary winding of the power transformer, protects the transformer against overload.

Pilot Lamp

A lamp, connected across the 6.3-volt secondary winding of the power transformer, lights when power is connected to the instrument circuits.

Frequency Range Selector

The Frequency Range Selector simultaneously selects the correct combination of oscillator and amplifier output tank coils to provide any of six rf ranges as indicated by the selector pointer. This control also mechanically positions a red-outlined circle along the vertical fiducial line of the FREQUENCY MC dial to indicate the active range.

FREQUENCY Control

The FREQUENCY control simultaneously adjusts the oscillator and amplifier tuning capacitors and drives the FREQUENCY MC dial. A small trimmer control in the center of the FREQUENCY control is used for independent tuning (peaking) of the rf amplifier. It is essential that the trimmer control be adjusted for maximum indication on the rf output meter and that the output meter be set to red line by means of the RF control in order to obtain maximum frequency stability and minimum spurious fm.

FREQUENCY MC Dial

The FREQUENCY MC dial, visible in the upper left-hand window, indicates the frequency of the output signal in megacycles. The total range of the instrument is covered in six ranges: 10-18.8 mc, 18.8-35.5 mc, 35.5-69 mc, 69-130 mc, 130-250 mc, and 250-500 mc. A red-outlined circle, positioned over the vertical fiducial line, indicates the active range.

VERNIER Control

The VERNIER control drives the FREQUENCY MC dial through a 10 to 1 reduction gear drive. A VERNIER dial on the control shaft is divided into 100 equal parts, providing a logging scale which divides any frequency range into 1000 parts.

AM SELECTOR

The AM SELECTOR switch provides connections for obtaining 400~ and 1000~ amplitude modulation from the internal audio oscillator and AM or pulse modulation from an external source. In OFF position the internal AM is disconnected. In order to avoid circuit interaction, it is advisable to disconnect the external AM when operating with the AM SELECTOR in the 400~ or 1000~ position. The AM SELECTOR should be set to the OFF position when the rf level is being adjusted to "red line".

AM LEVEL Control

This control provides a continuously variable means for adjusting the amplitude modulation level. A switch, actuated in the full-clockwise (PULSE) position of the control, shorts out the feedback circuit from the audio amplifier permitting pulse modulation from an external source. The rf amplifier trimmer control should be adjusted for maximum output and the RF control should be adjusted for "red line" output before the AM LEVEL control is adjusted.

RF Control

The RF control adjusts the rf drive level to the modulated amplifier and is used to set the pointer on the panel meter to the red line on the RF MONITOR scale. Before the RF control is adjusted, the amplifier trimmer control should be adjusted for maximum indication on the meter.

RF — % AM Switch (Meter Function Switch)

This switch switches the Panel Meter to either monitor the rf output or to indicate percent AM. The switch, normally in the RF position, is spring loaded for momentary operation to the % AM position.

Panel Meter

The meter in the upper right-hand window is used as an rf monitor or an indicator of percent AM, depending upon the position of the Meter Function Switch. The meter has two scales; an RF MONITOR scale for standardizing the input power level to the attenuator and a MODULATION scale for indicating the % AM produced by the audio signal.

NOTE: Off-scale operation of the rf monitor meter may cause spurious output frequencies and should therefore be avoided.

Attenuator Control

The attenuator control drives the rf output attenuator which is calibrated directly in both microvolts and decibels below 1 volt across an *external* 50-ohm load. The attenuator dial is direct reading when the panel meter pointer is set to "red line" on the RF MONITOR scale. On higher frequency bands the attenuator loading at settings above approximately 50 Kμv has some effect on the amplifier trimmer adjustment. Since proper tuning (peaking) of the amplifier minimizes spurious fm, it is advisable, at the higher frequencies, to preset the attenuator before trimming the amplifier and adjusting the rf level to "red line".

External Modulation Binding Posts

FM, GND, and AM binding posts are provided for connecting external fm, AM, and pulse modulation to the signal generator. Pulse modulation is connected to the AM terminals.

NOTE: The external pulse modulation limits are —20 volts and +0 volt. Since the grid of the rf amplifier tube (V203) is directly connected to the external AM terminals, a positive voltage should never be connected to these terminals.

RF OUTPUT Connector

The BNC type RF OUTPUT connector provides a convenient means for connection to the rf output of the signal generator. The Type 501-B Output Cable and Type 502-B Patching Cable, which may be connected to the RF OUTPUT of the signal generator for some applications, are described under Accessories Furnished in Section I.

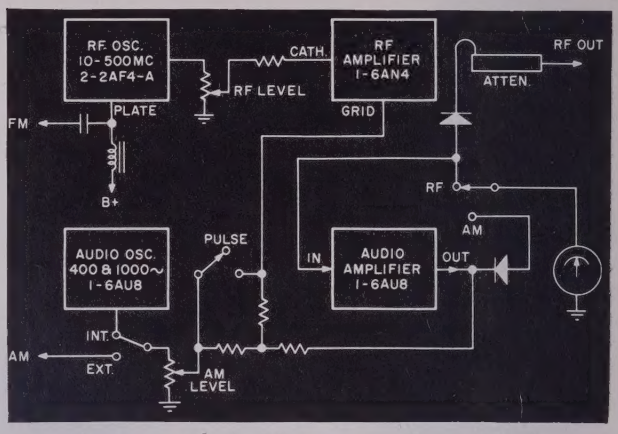


Figure 2. Block Diagram — Type 225-A

SECTION III
THEORY OF OPERATION

GENERAL

A functional block diagram of the Type 225-A Signal Generator is shown in Figure 2. Radio frequencies are generated in an oscillator circuit utilizing two push-pull operated 2AF4A triodes. Output from the oscillator is connected through a level control to the cathode of a tuned, grounded-grid rf amplifier stage employing a 6AN4 triode. This amplifier may be grid modulated by an internal audio oscillator providing a 400 or 1000-cycle output, or by an external AM source. The output of the amplifier is loop-coupled to a precision piston attenuator terminated at the RF OUTPUT connector on the front panel. The amplifier output is also loop-coupled to a monitor diode and connected through a meter function switch directly to a 20 μa meter on the front panel for normal rf monitoring; or through an ac-coupled amplifier, cathode follower circuit, and diode voltmeter to the same meter for AM monitoring. Some of the output voltage from the cathode follower circuit is returned out of phase with the incoming modulation voltage to reduce AM distortion. During external pulse modulation operation, this feedback network is shorted out by a switch, operated in the full clockwise position of the AM LEVEL control, so that signals may be applied directly to the grid of the rf amplifier. Audio voltage applied to the external FM posts, is impressed upon the plate of the rf oscillator generating low-deviation, uncalibrated frequency modulation.

RF OSCILLATOR

The oscillator circuit, shown in Figure 3, generates all of the radio frequencies in the 10 to 500-megacycle range of the instrument. The circuit employs two 2AF4A triodes with push-pull connected plates and grounded cathodes. Simple, fixed feedback is accomplished by means of capacitive dividers consisting of C3 and C4, together with the grid-to-cathode capacitance of the triodes. Chokes L3 and L4, along with good cathode grounding and short grid connections, serve to maintain high grid circuit impedance, preventing phase shift in the feedback voltage divider and consequential oscillation in the circuit at some frequencies.

Tuning of the oscillator is accomplished by means of a tank circuit which includes coil L1 and capacitors C1 and C2. Actually there are six different tank coils; one for each frequency range. The coils are wrapped on a specially formed turret which is detented into one of six frequency range positions by the Frequency Range Selector on the front panel. Wiping contacts are used to connect the selected coil into the tank circuit. The center of each tank coil is neutral and is used as a feed point for plate power which is connected through a switch operated by the turret drive, and a common supply ring on the turret. A 100-ohm resistor (R1) is connected between each coil and the B+ feed point to break up undesirable rf paths, without introducing appreciable plate voltage or rf loss.

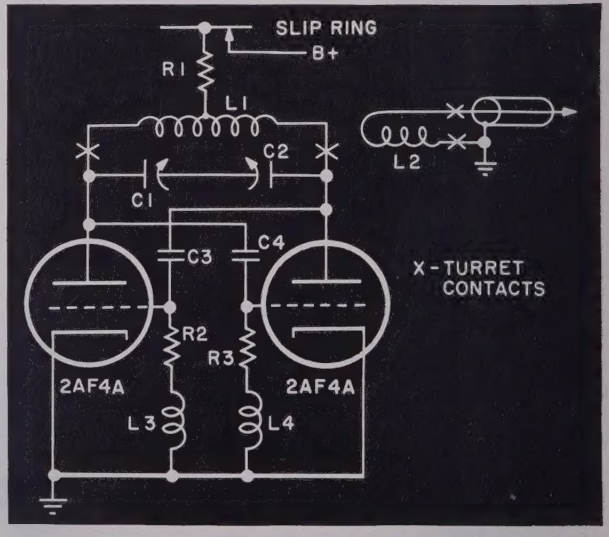


Figure 3. RF Oscillator Circuit

Output from the oscillator is coupled to a pick-up coil (L2) which is wrapped on the same turret form as the tank coil. The output from this coil is picked off the turret by another set of wiping contacts and fed through a coaxial cable to the rf amplifier modulator circuit.

AMPLIFIER MODULATOR

The modulator circuit, Figure 4, is a tuned grounded-grid triode amplifier which is grid modulated to provide simple, low-powered amplitude modulation. The circuit tank is similar to a push-pull tank, except that one tube has been replaced with a reactive network (C3, C4, and L2). This permits the use of a tank coil turret and tuning capacitor similar in design to those used in the oscillator circuit, and produces a circuit which will track naturally with the oscillator circuit.

A specially designed grid capacitor (C5) grounds the grid for RF signals but not for audio signals. This capacitor is a very low-inductance device which minimizes the inductance in the grid circuit, providing good stability and preventing positive feedback which could cause oscillation in the circuit.

An output level control (R3), incorporated in the coupling between the oscillator and the modulator, minimizes spurious frequency modulation and provides a means for maintaining the operating point of the modulation at an optimum level. The control is merely a variable resistive voltage divider into which the oscillator output is fed. Only enough voltage to drive the modulated amplifier to the level which produces 0.1-volt output is taken from the divider.

In order to reduce distortion, a different optimum grid bias is selected for each range by means of a switch coupled to the Frequency Range Selector.

Output from the amplifier modulator is coupled directly from the tank coil (L1) to the attenuator pickup coil.

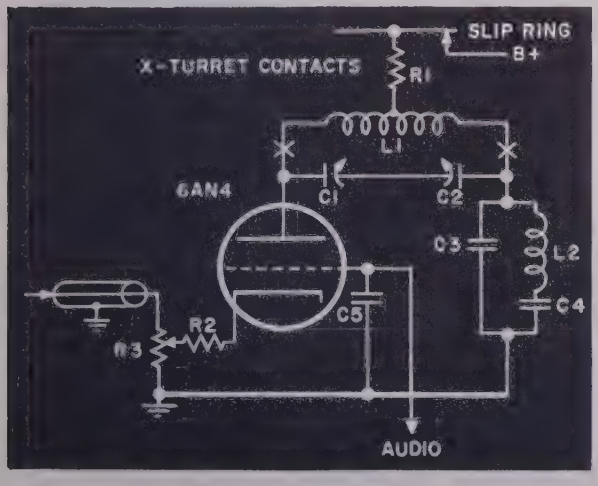


Figure 4. RF Amplifier Circuit

OUTPUT ATTENUATOR

A piston type RF attenuator is inductively coupled to the tank coil of the modulator by means of a single loop of wire in the same plane as the center turns of the tank coil. A 50-ohm carbon film resistor in series with the loop provides a 50-ohm source impedance. At the point where the loop connects to the output coaxial cable there is an impedance compensating circuit composed of a 50-ohm resistor and a capacitor in series to ground. This circuit tends to draw current of a leading phase when the loop phase is lagging, resulting in the maintenance of a good low VSWR source impedance from the attenuator output.

The attenuator dial is calibrated directly in microvolts and decibles below 1 volt open-circuit output across an external 50-ohm load. The output is standardized by setting the output monitor meter to the red reference line.

MONITOR SYSTEM

Between the attenuator tube and output tank, on either side of the plane occupied by the attenuator pickup coil, are two parallel monitor wires. One end of each of these is grounded and the other ends are tied to a 1N82A diode monitor. This monitor system therefore intercepts the same field that enters the piston attenuator tube and performs the monitor function for all ranges. The monitor loop also serves as a Faraday shield, allowing only the TE_{11} mode to propagate into the tube.

In order to accurately measure the amplitude modulation percentage as well as the RF output, the 1N82A monitor diode is by-passed for RF only. Amplitude modulation at an audio rate remains as an audio voltage imposed on the diode dc output. To monitor RF, diode output is fed directly to a 20 μa meter on the front panel through suitable calibrating resistors. For AM monitoring, the diode output is connected to an ac-coupled amplifier which builds up the audio envelope, then feeds it to a cathode follower. The cathode follower in turn drives a diode voltmeter which is fully bypassed for frequencies as low as 20 cps. This dc output is then switched to the same 20 μa meter through suitable calibrating resistors. The meter, which is marked for both % AM and RF Calibrate indications, normally reads RF but may be connected by means of a momentary contact switch to read % AM.

The output of the AM metering amplifier is used in another related manner. A certain percentage of the voltage from the cathode follower output is returned out of phase with the incoming modulation voltage. This tends to further reduce the AM distortion and provides a high degree of stability for the entire modulation system.

PULSE MODULATION

The inverse feedback from the cathode follower output of the AM metering amplifier is disconnected by a switch operated at the full-clockwise position of the AM LEVEL control during pulse operation. This

is done because the feedback circuit is an active reactance network which would tend to distort the pulse signals if connected between the AM terminals and the amplifier grid.

In pulse position a 10-volt negative pulse will turn off the RF amplifier. The pulse signals are dc coupled from the AM terminals to the grid of the amplifier and all that is connected between the AM terminals and the grid is an RF filter. For this reason, it is not desirable to swing this point in a positive direction. The minimum rise time is limited to 2 μs due to damping of the RF filter to prevent ringing or extreme overshoot.

FREQUENCY MODULATION

Means have been provided for amplitude modulating the plate of the oscillator from an external source. This provides low deviation frequency modulation (Figure 5) which, though uncalibrated, is somewhat predictable in magnitude and useful in the range above 100 mc where sufficient deviation is present for the narrow-band fm communications channels.

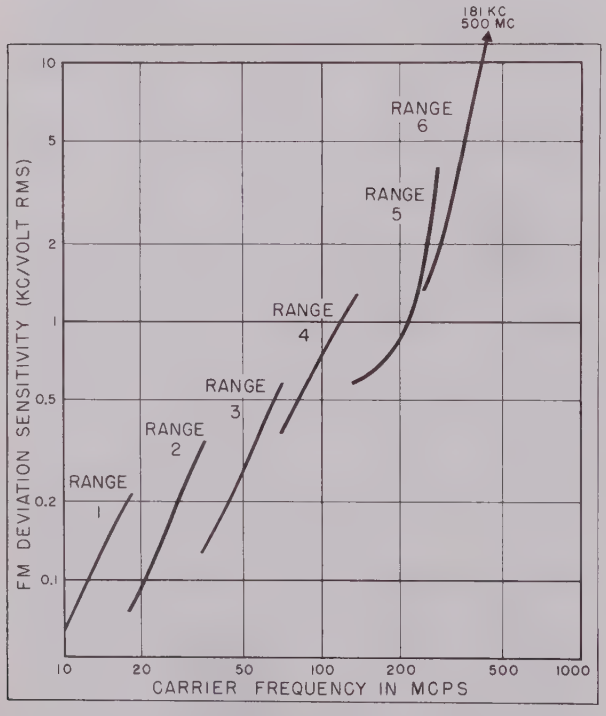


Figure 5. FM Deviation Sensitivity for 10V RMS, 1000 CPS Modulation Frequency (Values are Typical)

AUDIO OSCILLATOR

The internal audio frequency oscillator is a conventional R-C type oscillator which provides modulating frequencies of 400 or 1000 cycles. The R-C series and shunt combinations required to provide the desired modulating frequencies are selected by means of the AM Selector Switch on the front panel. A feedback control (R117) adjusts the modulation voltage level.

POWER SUPPLY

The power supply circuit utilizes a plate-filament regulating transformer which regulates the plate and filament voltages for a line voltage variation of from 100 to 130 volts. The 105-volt plate supply is regulated by a 105-volt glow tube. A series ballast regulator reduces the 6.3-volt filament to 2.3 volts.

SECTION IV
MAINTENANCE

OPENING THE INSTRUMENT

To gain access to the signal generator for the purpose of trouble shooting or component replacement, proceed as follows.

Removing Cover and Baseplate

1. Remove the end bells. (If the instrument is rack mounted, this will have been done during installation.)
2. Remove the six screws holding the cover to the top edge of the front panel and the rear edge of the baseplate.
3. Lift the cover off the instrument, pulling the power cord through the hole in the rear of the cover.
4. With the signal generator resting on its carrying handles, remove the seven screws holding the baseplate to the bottom of the instrument and remove the baseplate.

Removing Audio and Power Supply Chassis

In order to gain access to the rf assembly, it will be necessary to remove the audio and power supply chassis.

1. With the instrument resting on its carrying handles, loosen the setscrews on the AM LEVEL and AM SELECTOR control shaft couplers nearest the audio and power supply chassis.
2. Place the instrument in operating position and remove the eight screws holding the audio and power supply chassis to the left and right side supports.
3. Pull the chassis straight back, away from the front panel. Be careful not to strain the cable harnesses.

For access to the rf amplifier and rf oscillator circuit components, remove the eight screws which fasten the cover plates to the castings and remove the cover plates. The cover plates should be replaced in their original positions, during reassembly, so that a proper seal is maintained between the plates and the castings.

NOTE: It is recommended that components in the rf assembly, other than the tubes, be replaced at the factory only.

TUBE REPLACEMENT

All of the tubes in the signal generator except the two rf oscillator tubes (V201 and V202) and the constant current lamp (RT101) may be replaced with commercially available tubes. The two 2AF4A tubes in the rf oscillator should be replaced with Sylvania tubes only. Tubes purchased from other manufacturers may not contain the proper internal feedback capacitance and may not therefore operate at some points in the 250-mc to 500-mc frequency range. If oscillation ceases, excessive current will flow in the circuit and both V201 and 202 will be destroyed.

Lamp RT101 is selected and should be replaced with BRC Part Number 90907 only.

Replacement of certain tubes may necessitate readjustment of the signal generator circuits as shown below. When replacing tube V203, be careful not to disturb the monitor and pickup loops as this will upset the output calibration.

Tube Replaced	Adjustment to be Checked
V101	Audio Amplifier (R107)
	AM Calibration (R101)
V102	Audio Oscillator (R117)
V103, V105	Power Supply (R132)
*V201, V202	RF Oscillator (C205, C230)

*If either V201 or V202 fails, both tubes should be replaced. Be sure to turn off power before removing either of these tubes.

POWER SUPPLY ADJUSTMENT

Connect a VOM in series with pin 2 of V105 and a Variac between the signal generator and the power source. With the Variac set for 100 volts, the current through V105, as read on the VOM should be greater than 10 milliamperes. Adjust the Variac for 130 volts and observe the VOM reading. The current through V105 should be less than 40 milliamperes. Adjust by means of slide resistor R132 (Figure 9).

The voltage measured at pin 2 of V104 should be 6.3 vac $\pm$0.3 vac. The current measured in series with pin 7 of V104 should be 1.2 amp. $\pm$0.1 amp.

AUDIO OSCILLATOR ADJUSTMENT

Connect an ac VTVM (accurate to within $\pm$2%) to the AM terminals on the 225-A front panel. Set the AM SELECTOR to the 1000~ position and adjust R117 (Figure 8) until the VTVM indicates between 12.5 and 13 volts ac.

AUDIO AMPLIFIER ADJUSTMENT

With the AM SELECTOR on the 225-A set to OFF, connect a dc voltmeter across capacitor C102 (Figure 9). The voltmeter should indicate zero. Adjust by means of the BUCKING ADJ control, R107 (Figure 8).

AM CALIBRATION

Any of several methods may be used to check the AM calibration of the 225-A, the method used being determined by the test equipment available.

Using Type 245-C or D Signal Generator Calibrator

1. Connect the Signal Generator Calibrator to the RF OUTPUT connector on the 225-A front panel and set the AM SELECTOR on the 225-A to the 1000~ position.
2. Adjust the AM LEVEL control on the 225-A until the meter on the Signal Generator Calibrator indicates 30% AM.
3. Hold the RF — % AM switch on the 225-A in the % AM position and observe the Panel Meter on the 225-A. The meter should read 30% ($\pm$10% of full-scale reading in 10-250 mc range, $\pm$15% of full-scale reading in 250-500 mc range). Adjust by means of R101 (Figure 8).

Using An Oscilloscope

Calibration of the AM at the RF OUTPUT connector of the 225-A may also be checked by means of a modulated envelope display or a trapazoidal display on an oscilloscope. In most instances it will be necessary to use a frequency converter (such as the Type 207-E Univerter), connected between the 225-A and the oscilloscope, to accomodate the bandwidth of the oscilloscope being used. Care must be taken, however, to minimize envelope distortion in the mixer. Input to the mixer should be no more than 50,000 microvolts and the output from the mixer should be filtered to prevent direct demodulated audio from being fed to the oscilloscope. A 10 to 100 μh choke, shunted across the mixer output, will usually reduce this audio feed-thru.

With the 225-A and oscilloscope interconnected as shown in Figure 6, and the AM SELECTOR set to 1000~, the modulated rf output of the signal generator is displayed on the oscilloscope. The maximum (A) and minimum (B) modulation values from the displayed modulation envelope are applied to the equation:

$$\text{Percent AM} = \frac{A - B}{A + B} \times 100$$

and the percent modulation is computed.

For the trapazoidal method, the modulating audio signal is connected from the AM EXT MOD posts on the 225-A, with the AM SELECTOR in the EXT MOD position, to the "X" axis of the oscilloscope as shown in Figure 6 to produce a trapazoidal pattern. The maximum (A) and minimum (B) modulation values are then applied to the same equation used above, and the percent AM is computed.

The percent AM computed from either the modulation envelope method or the trapazoidal method should not deviate from the percent AM indication on the Front Panel meter of the 225-A by more than

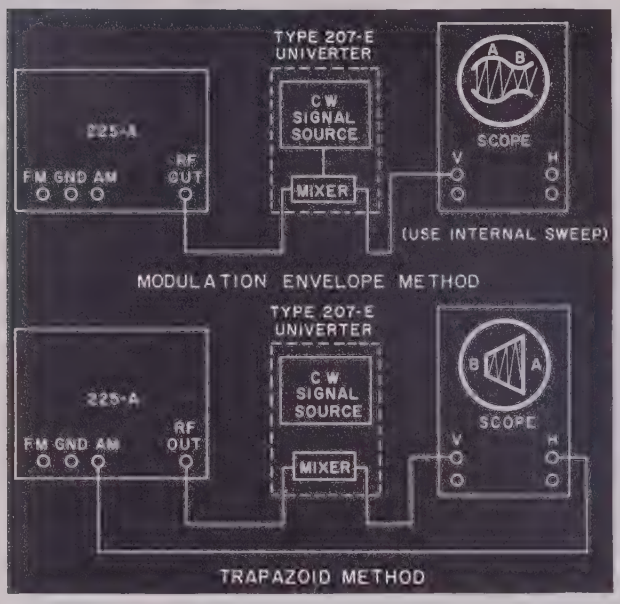


Figure 6. Connections for Calibrating AM

the accuracy tolerance specified in Section I under "Specifications". Adjust by means of R101 (Figure 8).

RF OSCILLATOR ADJUSTMENT

If the rf oscillator tubes (V201 or V202) are replaced or if there is reason to believe that the output frequency is not within specifications, the rf oscillator circuit may be adjusted as follows:

1. Connect a frequency counter or other frequency measuring device to the RF OUTPUT connector on the front panel of the 225-A, which has been warmed up for a 2-hour period.
2. Check the frequency at a low, center, and high point on each band (e.g. 67, 100, and 130 mc on the 67 to 130 mc range).
3. The FREQUENCY MC dial setting on the 225-A should be the same as the indication on the external frequency measuring device, within ±0.5%.
4. If the output frequency is out of specification tolerance for any dial setting, adjust C205 and C230 (Figure 9).

RF OUTPUT ADJUSTMENT

The rf output of the 225-A may be adjusted as follows:

1. Connect a suitable output measuring device (such as the Type 245-C or D Signal Generator Calibrator) to the RF OUTPUT connector on the 225-A.
2. Adjust the attenuator control until the attenuator dial reads 50K μv.
3. The rf output indicated on the Signal Generator Calibrator, or other measuring device, should be 50K μv (±10% on the 10 to 250-mc range, and ±15% on the 250 to 500-mc range) and the Panel Meter on the 225-A should indicate "red line".
4. Adjust by means of R105 (Figure 8).

TROUBLE SHOOTING

Data including socket and terminal block voltage measurements, a trouble-shooting chart giving some of the common troubles that might be encountered, and an overall schematic diagram have been included as an aid to trouble shooting.

Most cases of malfunctioning of the signal generator will probably be caused by tube deterioration. For this reason, it is recommended that one of the preliminary steps in the trouble-shooting procedure consist of an inspection of the tubes for lighted filaments. If all of the filaments are lighted and the trouble indicates faulty operation of a particular circuit or stage in the instrument, the tube or tubes in the circuit or stage concerned should be checked in a tube tester before further steps are taken.

VOLTAGE MEASUREMENTS

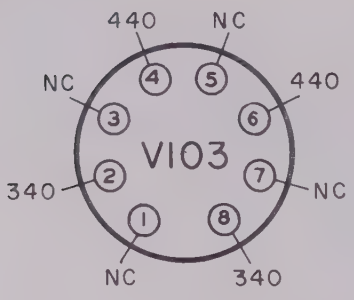
Voltage measurements made on a typical 225-A Signal Generator at the tube sockets and at the terminals of the terminal blocks in the audio and power supply assembly are given in Figure 7. All dc measurements were made with a 20K ohms-per-volt VOM. AC measurements were made with a ±2%, 10 to 150K cps VTVM.

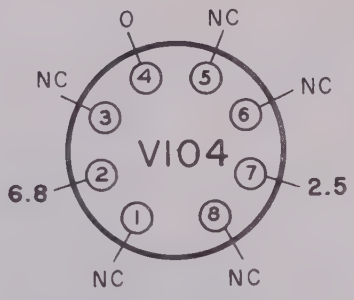
Typical voltage readings for the —4 volt amplifier modulator bias supply, measured at the swinger contact of S105, are given below.

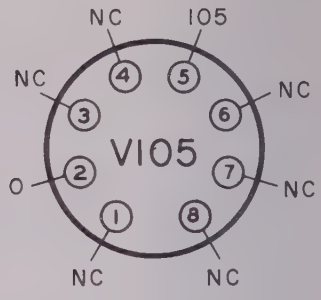
Range	Voltage Reading (dc)
1	3.8
2	3.65
3	3.5
4	2.7
5	2.5
6	1.5

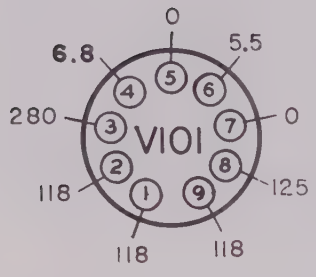
TROUBLE-SHOOTING CHART

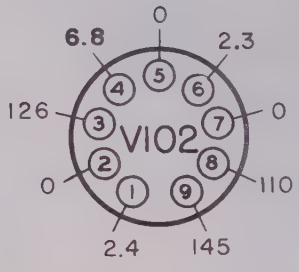
SYMPTOM	PROBABLE CAUSE	REMEDY
1. Filaments in RF Oscillator (V201 and V202 inoperative or overloaded).	V104, V201, or V202 defective. Filament overload due to defective component: C213, C214, L212, or L216.	Replace. (If either V201 or V202 is defective, replace both tubes.) Replace defective component.
2. No tube filaments light.	C118 or T101 defective.	Replace defective component.
3. Filaments light but there is no plate voltage.	V103 defective. R131 open. C104-A, C105-A, L102, or R132 defective.	Replace. Check for short to ground and replace resistor. Replace defective component.
4. Fuse, F101, blows repeatedly.	C118 or T101 defective.	Replace defective component.
5. No +105 voltage at oscillator.	R132 open. Switch S201 in oscillator open. V105 defective.	Replace. Adjust switch bracket. Replace.
6. RF output level low (frequency within specifications).	V203 defective. CR102 defective. Switch S105 open.	Replace. Replace. Repair open.
7. RF output level low (frequency out of specifications or no output at all at some points).	V201 or V202 defective.	Replace both tubes.
8. Stability versus line out of specifications.	R132 out of adjustment. V105 defective. C118 or T101 defective.	See Power Supply Adjustment. Replace — check Power Supply Adjustment. Replace defective component.
9. No modulation or inadequate modulation.	V102 defective. RT101 loose in socket or defective.	Replace — check Audio Oscillator Adjustment. Tighten or replace lamp.
10. Modulation indicator does not zero or read correctly.	V101 defective.	Replace — check Audio Amplifier Adjustment.
11. Panel Meter is erratic.	CR101 or CR201 defective.	Replace defective component.
12. Modulating waveform is square wave.	RT101 shorted.	Replace.
13. High recovered audio distortion.	—4 volt supply low. (See Voltage measurements). Switch S105 contacts open.	Replace CR102. Clean or adjust contacts.











NOTES

1. BOLD NUMBERS ARE A C. ALL OTHERS ARE D C.
2. TERMINAL BOARD LETTER DESIGNATIONS CORRESPOND TO LETTERS ASSIGNED ON FIG. 9.
3. N C INDICATES NO CONNECTION.
4. A M SELECTOR IN 400 ~ POSITION.
5. A M LEVEL – 30 %.

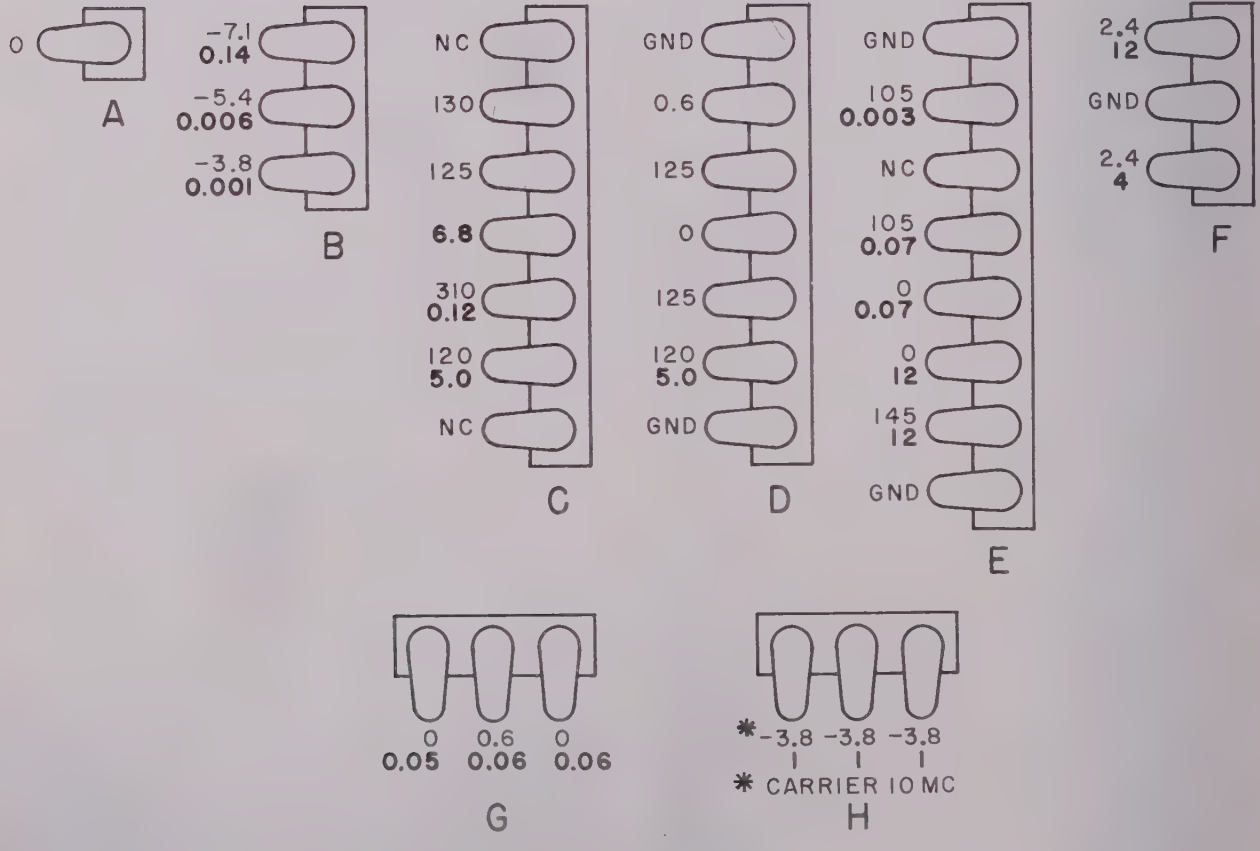


Figure 7. Voltage Measurements

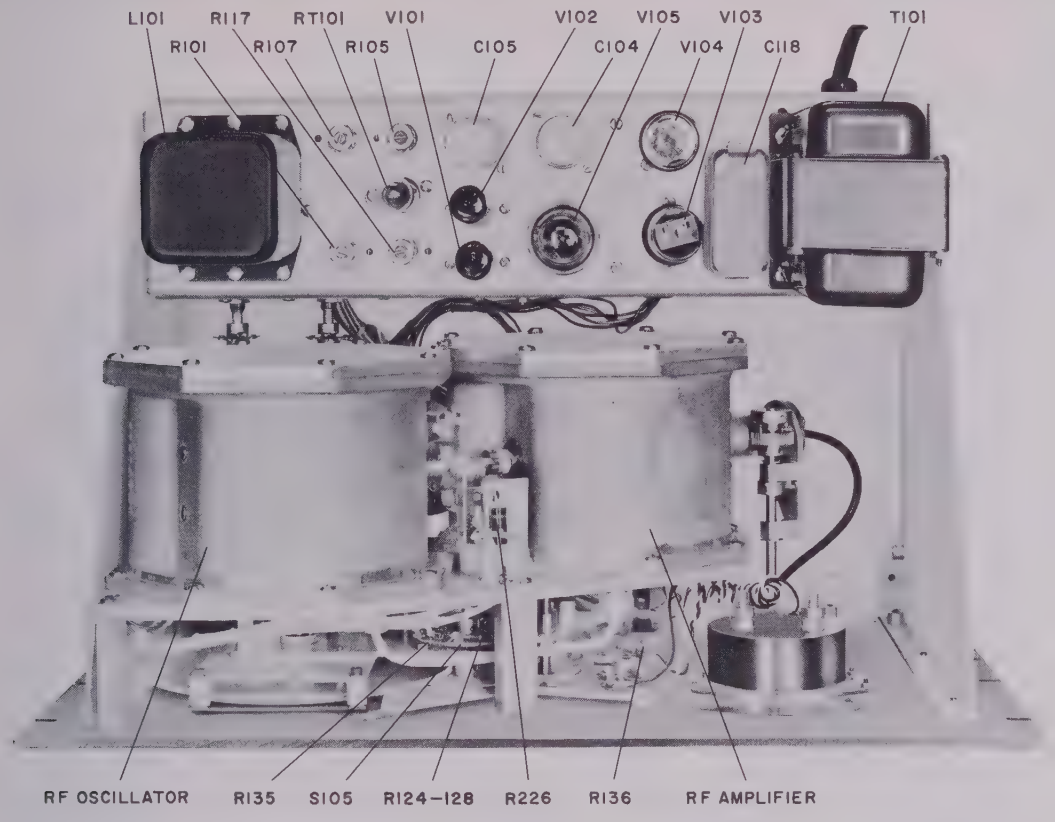


Figure 8. Type 225-A — Top View

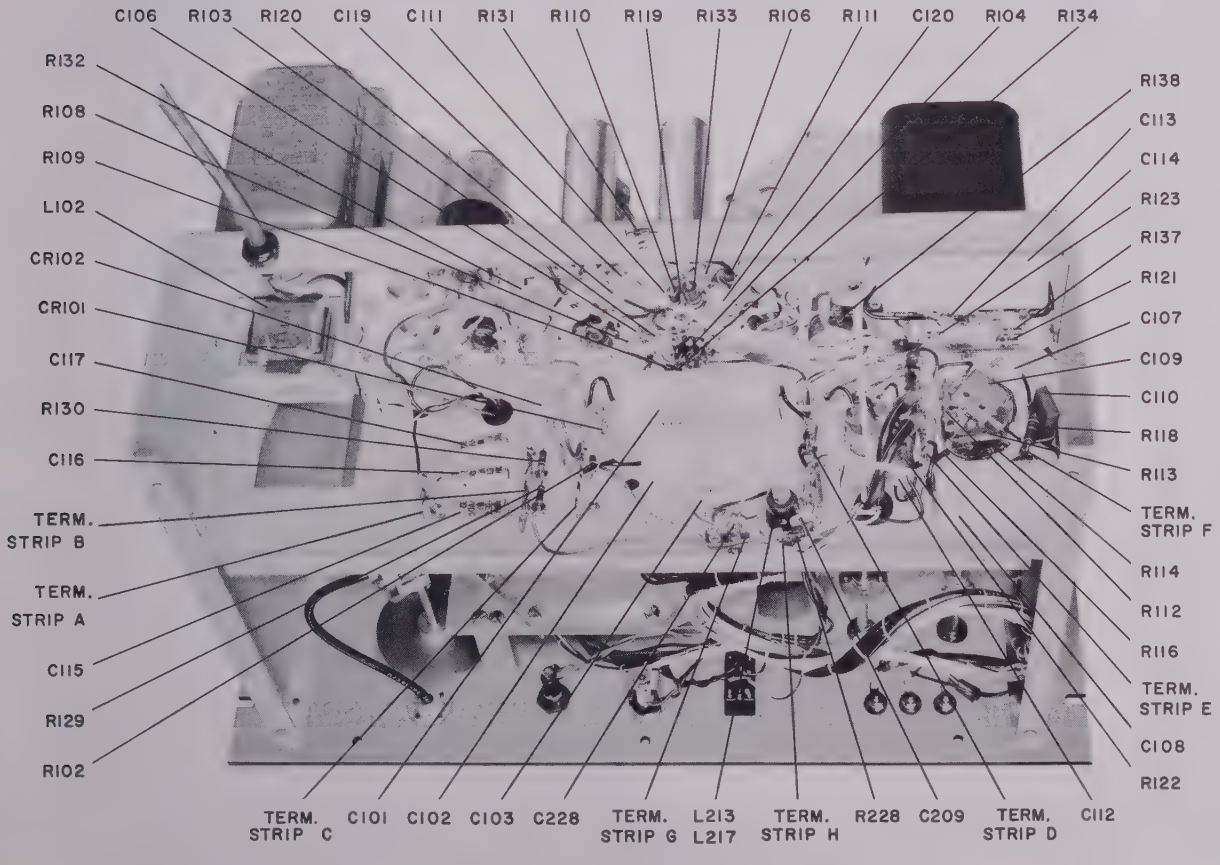


Figure 9. Type 225-A — Audio and Power Supply Chassis

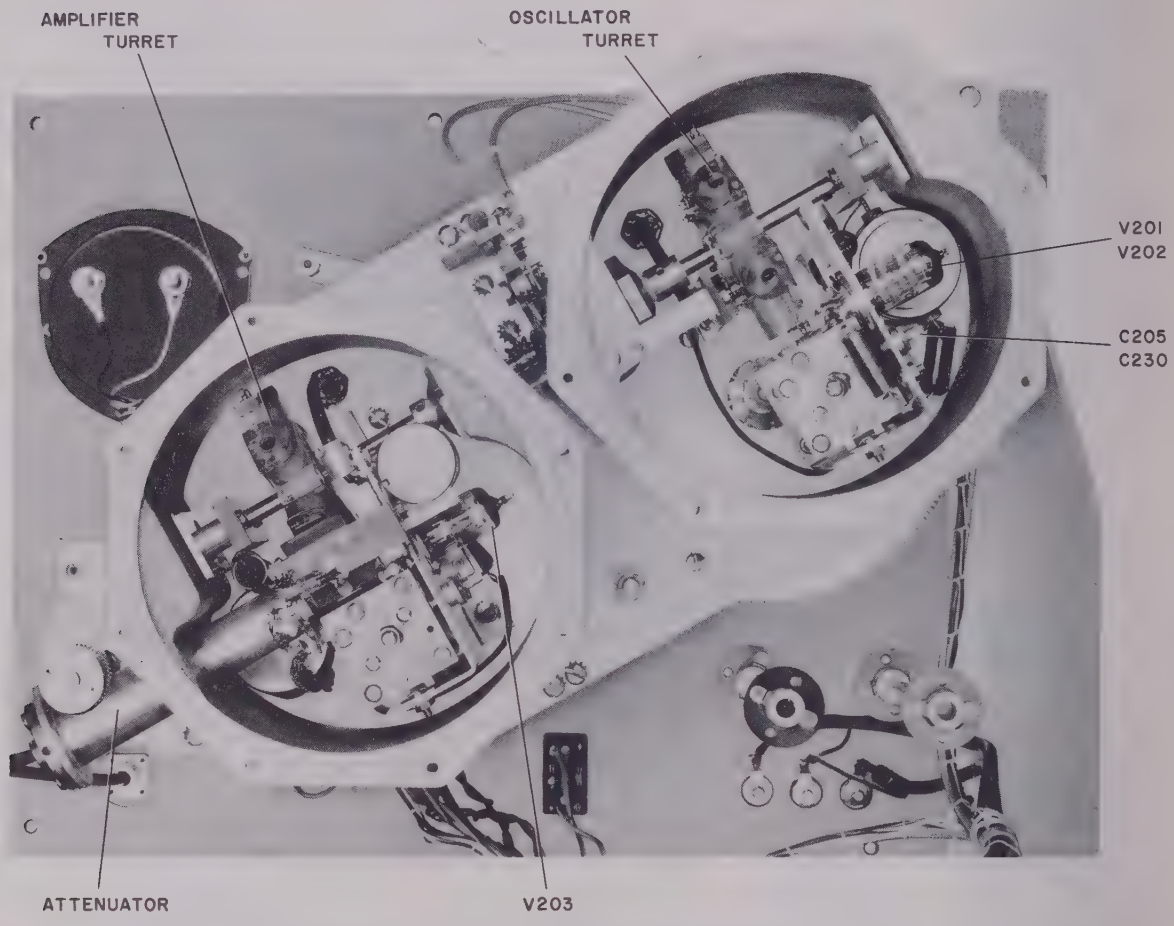


Figure 10. Type 225-A — RF Assembly

ELECTRICAL COMPONENTS

Audio — Power Supply Chassis

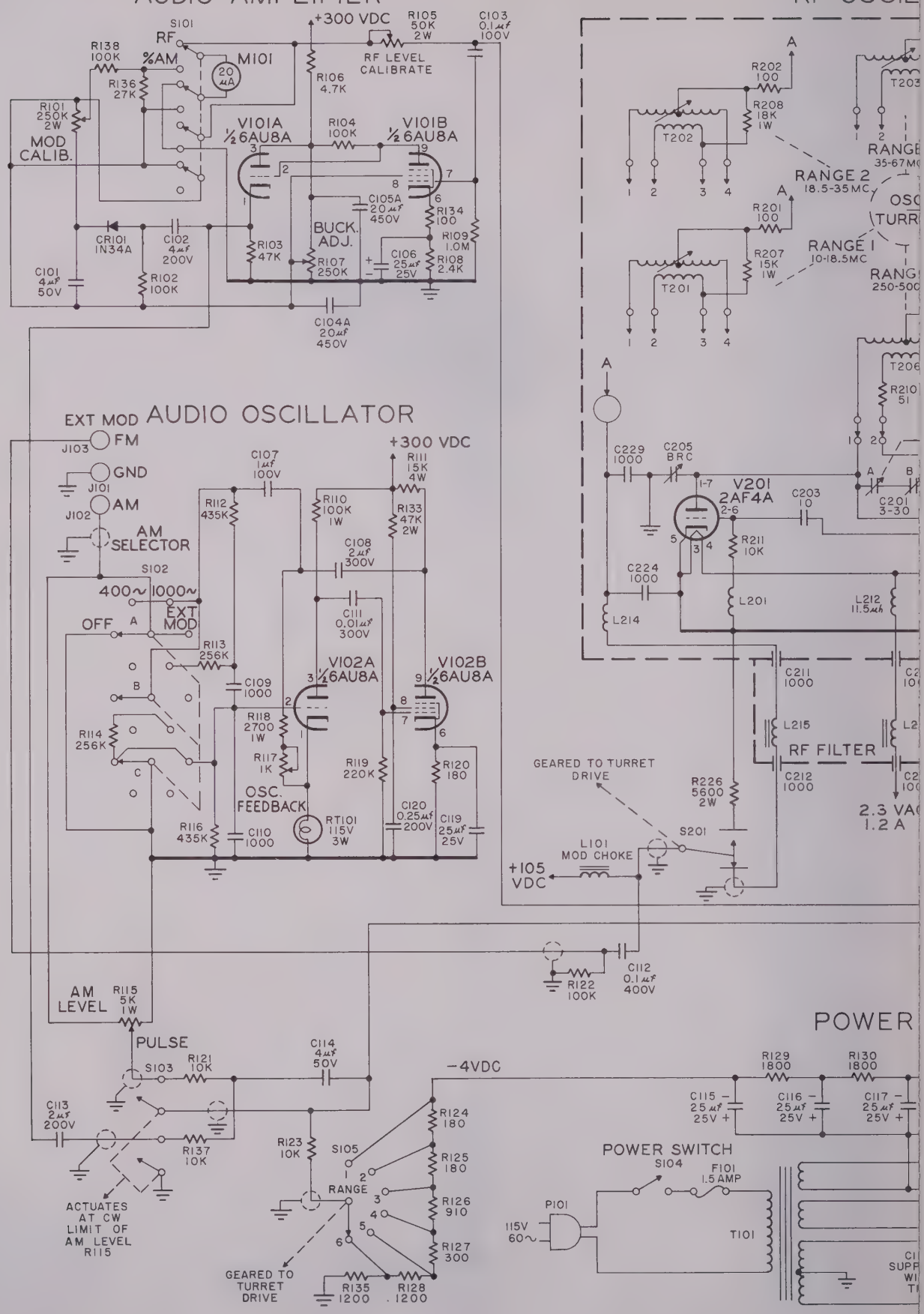
Circuit Symbol	Value	Description	Mfg's. Type No.	BRC Part No.
C101	4μf	Cap., Fixed: ±20%, 50v, Mylar	Good-All 663A	83127
C102	4μf	Cap., Fixed: ±20%, 200v, Mylar	Good-All 663A	83128
C103	0.1μf	Cap., Fixed: ±20%, 100v, Mylar	Good-All 663A	83124
C104,105	20-20μf	Cap., Fixed: 450v, Electrolytic	Cornell Dubilier 1545	83051
C106	25μf	Cap., Fixed: 25v, Electrolytic	Astron ET-25-25	83129
C107	1μf	Cap., Fixed: ±20%, 100v, Mylar	Good-All 663A	83125
C108	2μf	Cap., Fixed: ±20%, 200v, Mylar	Good-All 663A	83126
C109,110	1000μμf	Cap., Fixed: ±2%, 500v, Mica	Electro-Motive	82302
C111	0.01μf	Cap., Fixed: ±20%, 300v, Mylar	Good-All 663A	83123
C112	0.1μf	Cap., Fixed: −20+30%, 400v, Metalized Paper	Astron ML-4-1	83038
C113	2μf	Cap., Fixed: −20+30%, 200v, Metalized Paper	Astron MI-2-2M	83055
C114	4μf	Cap., Fixed: ±20%, 50v, Mylar	Good-All 663A	83127
C115,117	25μf	Cap., Fixed: 25v, Electrolytic	Astron ET-25-25	83129
C118		Cap., Fixed: Part of T101		
C119	25μf	Cap., Fixed: 25v, Electrolytic	Astron ET-25-25	83129
C120	0.25μf	Cap., Fixed: −20+30%, 200v, Metalized Paper	Astron ML-2-25	83023
CR101,102		Crystal Diode	Sylvania 1N34A	91081
F101		Fuse: 1.5 Amp.	Littlefuse 3AG	93250
I101		Lamp, Incandescent: 6.8v, 0.15 Amp.	GE TS47	90904
J101-103		Binding Post, Insulated	Grayhill 29-1B	304311
L101	8h	Choke, Filter Reactor: 105ma.	Chicago Transformer Corp. RC-8105	85436
L102	10h	Choke, Filter: 80ma.	Freed 11454	85402
M101		Meter, Modulation and Output: 0-20μa dc		305791
P101		Power Cord: 115v		01019
R101	250KΩ	Res., Variable: ±10%, 2w, Comp.	AB Type J	81601
R102	100KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80517
R103	47KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80460
R104	100KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80517
R105	50KΩ	Res., Variable: ±10%, 2w, Comp.	AB J-13497	81407
R106	4.7KΩ	Res., Variable: ±5%, ½w, Comp.	AB Type EB	80304
R107	250KΩ	Res., Variable: ±10%, ½w, Comp.	AB Type J	81601
R108	2.4KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80223
R109	1Meg.Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80621
R110	100KΩ	Res., Fixed: ±5%, 1w, Comp.	AB Type GB	80521
R111	15KΩ	Res., Fixed: ±5%, 4w, Comp.	AB Type HM	80434
R112	435KΩ	Res., Fixed: ±1%, ½w, Deposited Carbon	Electra DC1/2	80639
R113,114	256KΩ	Res., Fixed: ±1%, ½w, Deposited Carbon	Electra DC1/2	80637
R115	5KΩ	Res., Variable: ±10%, 1w, with switch S103	Chicago Tele. Supply FW7817 Sw. RWF-90CV	81309
R116	435KΩ	Res., Fixed: ±1%, ½w, Deposited Carbon	Electra DC1/2	80639
R117	1KΩ	Res., Variable: ±10%, 2w, Comp.	AB Type JLU-1021	81119
R118	2.7KΩ	Res., Fixed: ±5%, 1w, Comp.	AB Type GB	80239
R119	220KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80555
R120	180Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80222
R121	10KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80361
R122	100KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80517
R123	10KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80361
R124,125	180Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80222
R126	910Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80243
R127	300Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80244
R128	1.2KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80201
R129,130	1.8KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80234

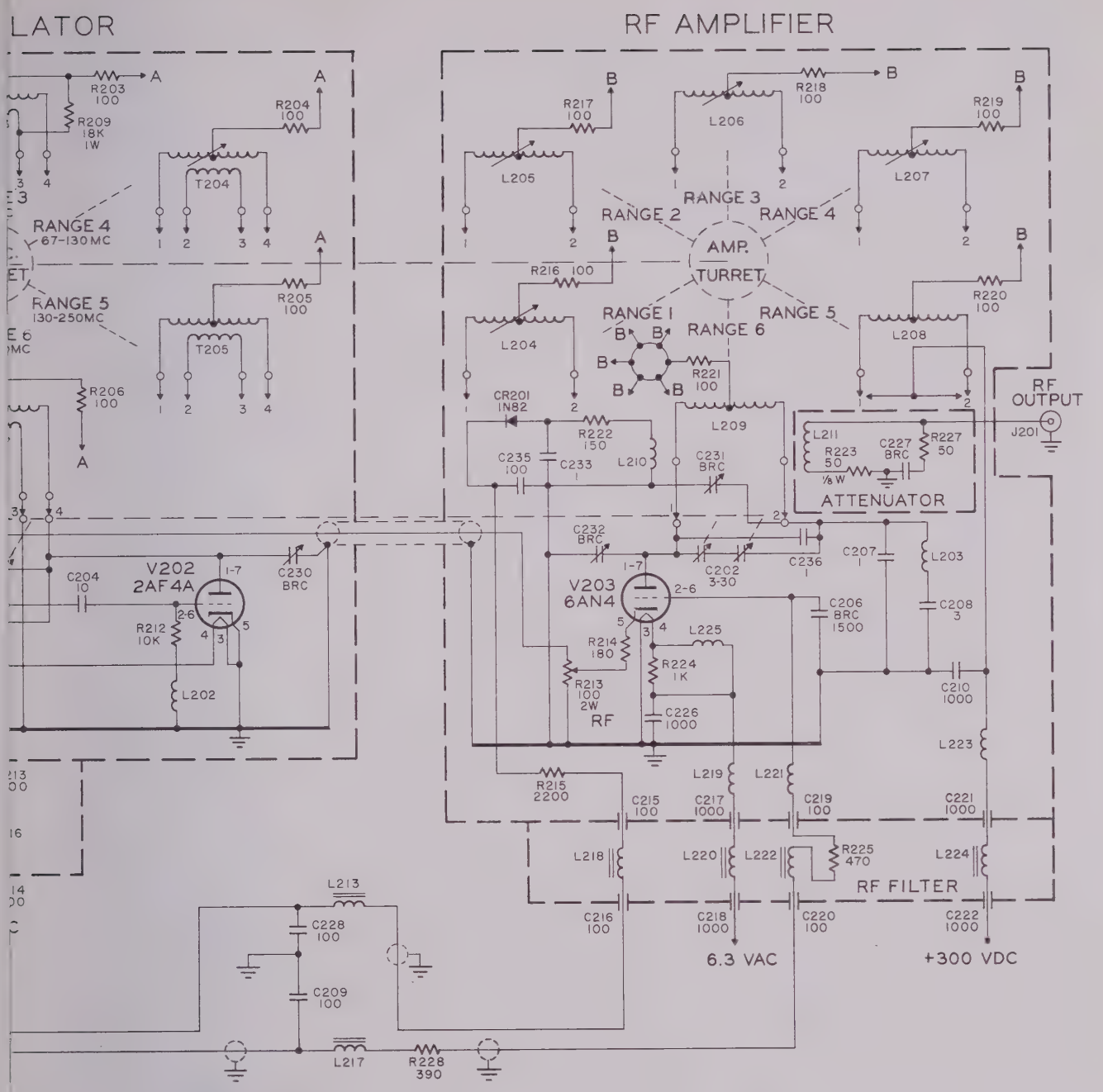
Circuit Symbol	Value	Description	Mfg's. Type No.	BRC Part No.
R131	330Ω	Res., Fixed: ±5%, 4w, Comp.	AB Type HM	80246
R132	4.5KΩ	Res., Variable: ±10%, 25w, Slide Wire	Clarostat Greenohm	80240
R133	47KΩ	Res., Fixed: ±5%, 2w, Comp.		80494
R134	100Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80062
R135	1.2KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80201
R136	27KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80298
R137	10KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80361
R138	100KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80517
RT101		Lamp: 115V, 3w (Selected 356/5)		90907
S101		Switch, Rotary: Spring Return	Oak Type 22	305940
S102		Switch, Rotary: 2 Sections, 4 Position, Non-shorting	Oak Type F	88098
S103		Switch: Part of R115 AM LEVEL Control		
S104		Switch, Toggle: DPDT	AH&H 81027CE	88059
S105		Switch, Rotary		88029
T101		Transformer, Plate and Filament Regulating: 60 cycles, 385vdc, with capacitor C118	Sola Type 7106	85035
		Transformer, Plate and Filament Regulating: 50 cycles, 385vdc, with capacitor C118	Sola Type 71B06	85037
V101,102		Tube, Electron: 6AU8A		
V103		Tube, Electron: 5Y3GT		
V104		Tube, Ballast: 12-3H		
V105		Tube, Electron: 0C3		
		RF Unit		
*C201	3-30μμf	Cap., Variable: Special		305757
*C202	3-30μμf	Cap., Variable: Special		306133
*C203,204	10μμf	Cap., Fixed:	Erie NP0A10	82039
*C205		Slug, Tuning		306180
*C206	1500μμf	Cap., Fixed: Special		306215
*C207	1μμf	Cap., Fixed: ±0.1μμf, Ceramic	Erie NP0A1	82037
*C208	3μμf	Cap., Fixed: ±0.1μμf, Ceramic	Erie NP0A3	82038
C209	100μμf	Cap., Fixed: ±20%, Standoff, Ceramic	AB SOS-1012	82152
*C210	1000μμf	Cap., Fixed: GMV Tol., Standoff, Ceramic	AB SOS-102W	82301
*C211,214	1000μμf	Cap., Fixed: GMV Tol., Ceramic	AB 5A5C-102W	82300
*C215,216	100μμf	Cap., Fixed: ±20%, Feedthru, Ceramic	AB 5A5C-1012	82151
*C217,218	1000μμf	Cap., Fixed: GMV Tol. Feedthru, Ceramic	AB 5A5C-102W	82300
*C219,220	100μμf	Cap., Fixed: ±20%, Feedthru, Ceramic	AB 5A5C-1012	82151
*C221,222	1000μμf	Cap., Fixed: GMV Tol., Feedthru, Ceramic	AB 5A5C-102W	82300
*C224	1000μμf	Cap., Fixed: GMV Tol., Standoff, Ceramic	AB SOS-102W	82301
*C226	1000μμf	Cap., Fixed: GMV Tol., Feedthru, Ceramic	AB 5A5C-102W	82300
*C227		Cap., Fixed: Special		306169
C228	100μμf	Cap., Fixed: ±20%, Standoff, Ceramic	AB SOS-1012	82152
*C229	1000μμf	Cap., Fixed: GMV Tol., Standoff, Ceramic	AB SOS-102W	82301
*C230-232		Slug, Tuning		306180
*C233	1μμf	Cap., Fixed: ±0.1μμf, Ceramic	Erie NP0A1	82037
*C235	100μμf	Cap., Fixed: ±20%, Standoff, Ceramic	AB SOS-1012	82152
*C236	1μμf	Cap., Fixed: ±0.1μμf, Ceramic	Erie NP0A1	82037
*CR201		Crystal Diode: 1N82	Sylvania	306241
*L201,202		Coil, RF		304990
*L203		Coil, RF		306216
*L204-209		Amplifier Turret and Coils		306268
*L210		Loop, RF Output Monitor		305887
*L211		Loop, Attenuator Coupler		305891

*It is recommended that these parts be replaced at the factory only.

Circuit Symbol	Value	Description	Mfg's. Type No.	BRC Part No.
*L212		Coil, RF		305812
L213,217		Coil, RF		305814
L214		Coil, RF		304990
*L215,216,218		Coil, RF		305814
*L219		Coil, RF		305812
*L220		Coil, RF		305814
*L221		Coil, RF		304990
*L222		Coil, RF		305814
*L223		Coil, RF		304990
*L224		Coil, RF		305814
*L225		Coil, RF		306201
J201		Connector, Receptacle: UG-291/U		89065
*R201,206	100Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80062
*R207	15KΩ	Res., Fixed: ±5%, 1w, Comp.	AB Type GB	80337
*R208,209	18KΩ	Res., Fixed: ±5%, 1w, Comp.	AB Type GB	80406
*R210	51Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80088
*R211,212	10KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80361
*R213	100Ω	Res., Variable: ±10%, 2w, Comp.	CTS 95	81016
*R214	180Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80222
*R215	2.2KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80256
*R216-221	100Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80062
*R222	150Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80098
*R223	50Ω	Res., Fixed: ±1%, ⅛w, Deposited Carbon	Dalohm DC1/8	80233
*R224	1KΩ	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80148
*R225	470Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80168
R226	5.6KΩ	Res., Fixed: ±5%, 2w, Comp.	AB Type HB	80408
*R227	50Ω	Res., Fixed: ±1%, ⅛w, Deposited Carbon	Dalohm DC1/8	80233
R228	390Ω	Res., Fixed: ±5%, ½w, Comp.	AB Type EB	80182
*T201,206		Oscillator Turret and Coils		306267
V201,202		Tube, Electron: 2AF4A (Use Sylvania only)		306203
V203		Tube, Electron: 6AN4		

*It is recommended that these parts be replaced at the factory only.


AUDIO AMPLIFIER
RF OSCIL
S101
RF
%AM
M101
20 μA
+300 VDC
R105 50K 2W
RF LEVEL CALIBRATE
C103 0.1 μf 100V
R138 100K
R136 27K
R101 250K 2W
MOD CALIB.
R106 4.7K
V101A ½6AU8A
R104 100K
V101B ½6AU8A
C105A 20 μf 450V
R134 100
R109 1.0M
BUCK. ADJ.
R108 2.4K
C106 25 μf 25V
CR101 IN34A
C102 4 μf 200V
R103 47K
R107 250K
C101 4 μf 50V
R102 100K
C104A 20 μf 450V
EXT MOD
AUDIO OSCILLATOR
J103 FM
GND
J101
J102 AM
AM SELECTOR
S102
400~ 1000~
EXT MOD
OFF
A
B
C
C107 1 μf 100V
R112 435K
R110 100K 1W
R111 15K 4W
R133 47K 2W
C108 2 μf 300V
C111 0.01 μf 300V
R113 256K
C109 1000
R114 256K
V102A ½6AU8A
V102B ½6AU8A
R118 2700 1W
R117 1K
OSC. FEEDBACK
RT101 115V 3W
R119 220K
R120 180
C120 0.25 μf 200V
C119 25 μf 25V
R116 435K
C110 1000
R202 100
R208 18K 1W
T202
T203
RANGE 2 18.5-35 MC
RANGE 35-67 MC
R201 100
R207 15K 1W
T201
RANGE 1 10-18.5 MC
RANGE 250-500
T206
R210 51
C229 1000
C205 BRC
V201 2AF4A
C203 10
C201 3-30
R211 10K
C224 1000
L201
L212 11.5 μh
L214
C211 1000
L215
RF FILTER
C212 1000
GEARED TO TURRET DRIVE
R226 5600 2W
S201
L101 MOD CHOKE
+105 VDC
2.3 VA
1.2 A
C112 0.1 μf 400V
R122 100K
AM LEVEL
R115 5K 1W
PULSE
S103
R121 10K
C114 4 μf 50V
-4VDC
POWER
R129 1800
R130 1800
C115 25 μf 25V
C116 25 μf 25V
C117 25 μf 25V
C113 2 μf 200V
R137 10K
ACTUATES AT CW LIMIT OF AM LEVEL R115
R123 10K
S105
RANGE
R124 180
R125 180
R126 910
R127 300
GEARED TO TURRET DRIVE
R135 1200
R128 1200
POWER SWITCH
S104
F101 1.5 AMP
P101
115V 60~
T101



NOTES

UNLESS OTHERWISE NOTED:

CAPACITANCE IS IN MICROMICROFARADS.

RESISTANCE IS IN OHMS (K=1,000 OHMS, M=1,000,000 OHMS).

INDUCTANCE IS IN MICROHENRIES.

Figure 11. Schematic Diagram

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